DECLARATION

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1. A fuel cell power generation system comprising:

a fuel processor which generates a hydrogen-rich fuel gas by reacting a material and steam;

a fuel cell which performs power generation using the fuel gas and an oxidizing gas;

a load power detecting means which detects a load power; and

a controller configured to control operation start and stop and a series of operations from the operation start to the power generation;

wherein the controller includes a time detecting means which detects time; an operation stop determination means which stops the operation when the load power detected by the load power detecting means is below a predetermined power threshold for predetermined time or predetermined frequency within predetermined time; a power threshold setting means which sets the predetermined power threshold; a predetermined time setting means which sets the predetermined time, and a predetermined frequency setting means which sets the predetermined frequency, wherein either the predetermined power threshold and the predetermined time, or the predetermined power threshold, the predetermined time, and the predetermined frequency are changed in daytime period and in nighttime period.

2. The fuel cell power generation system according to claim 1, wherein the power threshold is an instant power threshold, and the operation is stopped when an instant value of the load power detected by the load power detecting means is below the instant power threshold for predetermined time.

3. The fuel cell power generation system according to claim 1, wherein the power threshold is an instant power threshold, and the operation is stopped when a frequency at which an instant value of the load power detected by the load power detecting means is below the instant power threshold is more than the predetermined frequency within the predetermined time.

4. The fuel cell power generation system according to claim 1, wherein the power threshold is an integrated power threshold, and the operation is stopped when an integrated value of the load power detected by the load power detecting means is below the integrated power threshold within the predetermined time.

5. The fuel cell power generation system according to claim 1 to 4, wherein a power threshold Wd for daytime period and a power threshold Wn for nighttime period are set such that Wd < Wn.

6. The fuel cell power generation system according to claim 1 to 4, wherein predetermined time Td for daytime period and predetermined time Tn for nighttime period are set such that Td > Tn.

7. The fuel cell power generation system according to claim 1 to 4, wherein predetermined frequency Fd for daytime period and predetermined time Fn for nighttime period are set such that Fd > Fn.

8. A method of operating a fuel cell power generation system including: a fuel processor which generates a hydrogen-rich fuel gas by reacting a material and steam; a fuel cell which performs power generation using the fuel gas and an oxidizing gas; a load power detecting means which detects a load power; and a controller configured to control operation start and stop and a series of operations from the operation start to the power generation; the method comprising:

a time detecting step for detecting time;

an operation stop determination step for stopping the operation when the load power detected by the load power detecting means is below a predetermined power threshold for predetermined time or predetermined frequency within predetermined time;

a power threshold setting step for setting the predetermined power threshold;

a predetermined time setting step for setting the predetermined time;

a predetermined frequency setting step for setting the predetermined frequency; and

a step for changing either the predetermined power threshold and the predetermined time, or the predetermined power threshold, the predetermined time, and the predetermined frequency in daytime period and in nighttime period.

9. The method of operating the fuel cell power generation system according to claim 8, wherein the operation stop determination step is a step for stopping the operation when an instant value of the load power detected by the load power detecting means is below the instant power threshold for predetermined time.

10. The method of operating the fuel cell power generation system according to claim 8, wherein the operation stop determination step is a step for stopping the operation when a frequency at which an instant value of the load power detected by the load power detecting means is below the instant power threshold is more than the predetermined frequency within the predetermined time.

11. The fuel cell power generation system according to claim 8, wherein the operation stop determination step is a step for stopping the operation when an integrated value of the load power detected by the load power detecting means is below the integrated power threshold within the predetermined time.

12. A program for causing a computer to operate as a whole or a part of the fuel cell power generation system according to claim 1 including a load power detecting means which detects a load power; a control means configured to control operation start and stop and a series of operations from the operation start to the power generation; a time detecting means which detects a current time; an operation stop determination means which stops the operation when the load power detected by the load power detecting means is below a predetermined power threshold for predetermined time or

predetermined frequency within predetermined time; a power threshold setting means which sets the predetermined power threshold; a predetermined time setting means which sets the predetermined time, and a predetermined frequency setting means which sets the predetermined frequency; and a means for changing at least either the predetermined power threshold and the predetermined time, or the predetermined power threshold, the predetermined time, and the predetermined frequency are changed in daytime period and in nighttime period.

[Name of Document] Specification

[Title of the Invention] Fuel cell Power Generation System, Operation Method of Fuel Cell Power Generation System, and Program of Fuel Cell Power Generation System

[Technical Field]

[0001]

The present invention relates to a fuel cell power generation system configured to perform power generation using a fuel cell, and an operation method of the fuel cell power generation system.

[Background Art]

[0002]

In an operation of the conventional power generation system including a fuel cell power generation system, power resulting from the power generation system and commercial power are used together in a time period in which a power load is large in amount, while only the commercial power is supplied in a time period in which the power load is small in amount (see for example, patent document 1). Also, output control is executed according to a detected power load, and an operation is stopped when the power load is not more than a threshold (see patent document 2).

[0003]

Fig. 6 is a diagram showing the conventional fuel cell power generation system disclosed in the patent document 2. Fig. 7 shows an example of an operation pattern of the conventional fuel cell power generation system.

[0004]

As shown in Fig. 6, the conventional fuel cell power generation system comprises

a fuel cell 101, an output control means 102, and a load power detecting means 103 which are connected in series in this order, a power load 104 which is connected to the load power detecting means 103 and consumes electric power, and a storage battery 105 connected to a connecting portion between the output control means 102 and the load power detecting means 103.

[0005]

The output control means 102 executes start-up and stop of the system and control for the output power of the fuel cell 101 so as to respond to the power of the power load 104 which is detected by the power load detecting means 103. Also as shown in Fig. 7, when load power 111 transitions from night 111d when the load power 111 is large in amount to midnight 111e when the load power 111 is small in amount, for example, the load power which is not higher than a power threshold W1b continues for predetermined time T1b or more (threshold for determining whether or not to stop the operation), the system is stopped.

[Patent Document 1] Japanese Laid-Open Patent Application Publication No. 2000-299116 (page 4 to 5)

[Paten Document 2] Japanese Laid-Open Patent Application Publication No. 2002-352834 (page 7 to 8, Fig 1)

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0006]

However, in the above described conventional fuel cell power generation system, when the operation illustrated in Fig. 7 is performed, energy is discarded.

[0007]

To be more specific, in the conventional fuel cell power generation system, in the case of afternoon 111c when the power load is small in amount and load power which is not higher than power threshold W1b continues for more than predetermined time T1b, the system is stopped and the system is re-started-up at night 111d. Since the start-up is conducted twice per day, the energy is discarded for unnecessary stop and start-up operation. The unnecessary stop and start-up operation causes undesired energy

consumption and reduces total efficiency, because start-up time is longer in the fuel cell power generation system which reforms a material such as a city gas to generate a hydrogen-rich fuel gas than in other power generation system, for example, engine power generation system.

[0008]

The present invention is aimed at solving the problem associated with the prior art. An object of the present invention is to provide a fuel cell power generation system and an operation method of the fuel cell power generation system which are capable of continuing preferable operation by changing a threshold for determining whether or not to stop operation in daytime period and in nighttime period, thereby reducing the number of times the operation is stopped is reduced and reducing the number of times wasteful energy is consumed for start-up, when the power load is low in daytime period.

[Means for Solving the Problem]

[0009]

To solve the problem associated with the prior art, a fuel cell power generation system of the present invention, comprises a fuel processor which generates a hydrogen-rich fuel gas by reacting a material and steam; a fuel cell which performs power generation using the fuel gas and an oxidizing gas; a load power detecting means which detects a load power; and a controller configured to control operation start and stop and a series of operations from the operation start to the power generation; wherein the controller includes a time detecting means which detects time; an operation stop determination means which stops the operation when the load power detected by the load power detecting means is below a predetermined power threshold for predetermined time or predetermined frequency within predetermined time; a power threshold setting means which sets the predetermined power threshold; a predetermined time setting means which sets the predetermined time, and a predetermined frequency setting means which sets the predetermined frequency, wherein either the predetermined power threshold and the predetermined time, or the predetermined power threshold, the predetermined time, and the predetermined frequency are changed in daytime period

and in nighttime period.

[0010]

In such a configuration, preferable operation can be continued under the state where the number of times of operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced when the power load is low in daytime period.

[0011]

It is preferable that in the fuel cell power generation system of the present invention, the power threshold is an instant power threshold, and the operation is stopped when an instant value of the load power detected by the load power detecting means is below the instant power threshold for predetermined time.

[0012]

It is preferable that in the fuel cell power generation system of the present invention, the power threshold is an instant power threshold, and the operation is stopped when a frequency at which an instant value of the load power detected by the load power detecting means is below the instant power threshold is more than the predetermined frequency within the predetermined time.

[0013]

It is preferable that in the fuel cell power generation system of the present invention, the power threshold is an integrated power threshold, and the operation is stopped when an integrated value of the load power detected by the load power detecting means is below the integrated power threshold within the predetermined time.

[0014]

It is preferable that in the fuel cell power generation system, a power threshold Wd for daytime period and a power threshold Wn for nighttime period are set such that $Wd < Wn$.

[0015]

It is preferable that in the fuel cell power generation system, predetermined time Td for daytime period and predetermined time Tn for nighttime period are set such that $Td > Tn$.

[0016]

It is preferable that in the fuel cell power generation system, predetermined frequency Fd for daytime period and predetermined time Fn for nighttime period are set such that Fd > Fn.

[0017]

According to the present invention, there is provided a method of operating a fuel cell power generation system including: a fuel processor which generates a hydrogen-rich fuel gas by reacting a material and steam; a fuel cell which performs power generation using the fuel gas and an oxidizing gas; a load power detecting means which detects a load power; and a controller configured to control operation start and stop and a series of operations from the operation start to the power generation; the method comprising: a time detecting step for detecting time; an operation stop determination step for stopping the operation when the load power detected by the load power detecting means is below a predetermined power threshold for predetermined time or predetermined frequency within predetermined time; a power threshold setting step for setting the predetermined power threshold; a predetermined time setting step for setting the predetermined time; a predetermined frequency setting step for setting the predetermined frequency; and a step for changing either the predetermined power threshold and the predetermined time, or the predetermined power threshold, the predetermined time, and the predetermined frequency in daytime period and in nighttime period.

[0018]

It is preferable that in the method of operating the fuel cell power generation system of the present invention, the operation stop determination step is a step for stopping the operation when an instant value of the load power detected by the load power detecting means is below the instant power threshold for predetermined time.

[0019]

It is preferable that in the method of operating the fuel cell power generation system of the present invention, the operation stop determination step is a step for stopping the operation when a frequency at which an instant value of the load power

detected by the load power detecting means is below the instant power threshold is more than the predetermined frequency within the predetermined time.

[0020]

It is preferable that in the method of operating the fuel cell power generation system of the , the operation stop determination step is a step for stopping the operation when an integrated value of the load power detected by the load power detecting means is below the integrated power threshold within the predetermined time.

[0021]

According to the present invention, there is provided a program for causing a computer to operate as a whole or a part of the above fuel cell power generation system including a load power detecting means which detects a load power; a control means configured to control operation start and stop and a series of operations from the operation start to the power generation; a time detecting means which detects a current time; an operation stop determination means which stops operation when the load power detected by the load power detecting means is below a predetermined power threshold for predetermined time or predetermined frequency within predetermined time; a power threshold setting means which sets the predetermined power threshold; a predetermined time setting means which sets the predetermined time, and a predetermined frequency setting means which sets the predetermined frequency; and a means for changing at least either the predetermined power threshold and the predetermined time, or the predetermined power threshold, the predetermined time, and the predetermined frequency are changed in daytime period and in nighttime period.

[Effects of the Invention]

[0022]

In accordance with the fuel cell power generation system and the operation method of the fuel cell power generation system of the present invention, by changing the threshold for determining whether or not to stop the operation in daytime and in nighttime, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced when the power load is low in daytime

period.

[Best Mode for Carrying Out the Invention]

[0023]

Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[0024]

(Embodiment 1)

Fig. 5 is a diagram showing a construction of the fuel cell power generation system according to the first embodiment of the present invention. First of all, a construction of the fuel cell power generation system according to the first embodiment of the present invention will be described with reference to Fig. 5.

[0025]

As shown in Fig. 5, a fuel cell power generation system comprises a fuel processor 201 configured to generate a hydrogen-rich fuel gas through steam reforming of a material, a fuel cell 202 configured to generate electric power using the fuel gas and an oxidizing gas, an air blower 203 configured to supply air as the oxidizing gas to the fuel cell 202, an inverter 204 configured to convert a DC power resulting from power generation in the fuel cell 202 into an AC power, a load power detecting means 205 that detects power consumption of the power load, and a control portion 206 configured to control start and stop of the operation of the fuel cell power generation system, a series of operations from the start of the operation to the power generation.

[0026]

The control portion 206 includes a power amount changing means 207 configured to change an output power amount according to the load power which is detected by the load power detecting means 205, a timer 208 configured to detect a current time, and determine daytime period or nighttime period, an operation stop determination means 209 configured to stop the operation of the system when the power load detected is below a preset power threshold for stopping the operation of the system for a preset predetermined time, or when the power load is below the preset power threshold a preset predetermined frequency within the predetermined time , a power

threshold setting means 210, a predetermined time setting means 211, and a predetermined frequency setting means 212 that are respectively configured to set a power threshold, a predetermined time, and a predetermined frequency, which are conditions for stopping the operation of the system.

[0027]

213 denotes a power load configured to consume the power generated in the fuel cell power generation system and the commercial power.

[0028]

Subsequently, the operation of the fuel cell power generation system according to this embodiment will be described with reference to Fig. 1 which is a graph showing an example of an operation pattern of a fuel cell power generation system according to this embodiment. Also, one embodiment of the operation method of the fuel cell power generation system of the present invention will be described while explaining the operation of the fuel cell power generation system of this embodiment (The same applies to the embodiments below).

[0029]

The example of the operation pattern in Fig. 1 may be considered to show a model of the operation pattern one day at home. In Fig. 1, an ordinate axis indicates a power and an abscissa axis indicates a time, 311 and 312 denote load power, and output power, respectively. The load power 311 is large in amount from morning to daytime 311b and at night 311d and is small in amount at midnight 311e and early morning 311a. In afternoon 311c, there is a time period in which the load power is small in amount. The fuel cell 202 is operation-controlled at output power 312 according to the power consumed by the power load 213 by the power generation amount changing means 207 in the control portion 206 between a maximum output power W1c and a minimum output power W1d. Also, in the timer 208 of the control portion 206, for example, 6:00 to 18:00 is set as daytime period and 18: 00 to 6:00 is set as nighttime period. The timer 208 outputs those information. In the power threshold setting means 210, a power threshold W1bd for daytime period and a power threshold W1bn for nighttime period are pre-set. Predetermined time T1b is pre-set in the predetermined setting

means.

[0030] In this embodiment, when load power 311 transitions from early morning 311a when the load power 311 is small in amount to morning 311b when the load power 311 is large in amount, for example, the load power which is not lower than a power threshold W1a continues for predetermined time T1a or more, the system is started-up. In contrast, when load power 311 transitions from night 311d when the load power 311 is large in amount to midnight 311e when the load power 311 is small in amount, for example, the load power which is not higher than a power threshold W1b continues for predetermined time T1b or more, the system is stopped. Although there is a time period in which the load power is small in amount in afternoon 311c in Fig. 1, the operation is continued at the minimum output power W1d because the load power which is not higher than the power threshold W1bd does not continue for the predetermined time T1b or more.

[0031] In accordance with the configuration of the fuel cell power generation system in this embodiment, as the power threshold W1b which is condition for stopping the system, the power threshold W1bd for daytime period and the power threshold W1bn for nighttime period are pre-set in the power threshold setting means 210. Thereby, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced even in the time period of in afternoon 311c when the load power is small in amount.

[0032] When the power threshold W1bd for daytime period and the power threshold W1bn for nighttime period are set such that W1bd < W1bn, generation of the operation stop condition in daytime period can be made less. Therefore, unnecessary stop operation is reduced and energy consumption for the stop and the associated start-up next time can be minimized. It should be noted that the power threshold W1bd for daytime period and the power threshold W1bn for nighttime period may be set by a user (or operator, manager) of the fuel cell power generation system, or operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them in the power threshold setting means 210. Whereas the power threshold

W1bd for daytime period and the power threshold W1bn for nighttime period are described as instant power amounts in this embodiment, the operation may be performed in such a manner that the power threshold W1bd for daytime period and the power threshold W1bn for nighttime period may be set as thresholds for integrated power amount detected by the load power detecting means in the predetermined time T1b which is preset. Thereby, likewise, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced even in the time period of the afternoon 311c when the load power is small in amount.

[0033]

In this embodiment, "the daytime period and the nighttime period are set in the timer 208." This setting may be conducted by the user (or operator, manager) of the fuel cell power generation system. Alternatively, operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them in the timer 208. In a further alternative, the control portion 206 may set first system start-up in one day as a start in daytime, and set it in the timer 208. Whereas in this embodiment, time periods in "daytime period and nighttime period" are each set to 12 hours, the time period in the daytime period may be set longer or the time period in the nighttime period may be set longer.

[0034]

(Embodiment 2)

Next, a construction and operation of the fuel cell power generation system according to this embodiment will be described with reference to Fig. 2 which is graph for explaining an example of an operation pattern of the fuel cell power generation system of this embodiment.

[0035]

The construction and operation of the fuel cell power generation system of this embodiment are similar to those of the above described fuel cell power generation system of the first embodiment. In Fig. 2, an ordinate axis indicates a power and an abscissa axis indicates a time, respectively. Load power 321 is large in amount from

morning to daytime period 321b and at night 321d and is small in amount at midnight 321e and early morning 321a. In afternoon 321c, there is a time period in which the load power is small in amount. In this embodiment, the fuel cell 202 is operation-controlled at output power 322 according to the power consumed by the power load 213 between the maximum output power W2c and the minimum output power W2d.

[0036]

Also, in the timer 208 of the control portion 206, for example, 6:00 to 18:00 is set as daytime period and 18: 00 to 6:00 is set as nighttime period. The timer 208 outputs those information. In the power threshold setting means 210, a power threshold W2bd for daytime period and a power threshold W2bn for nighttime period are pre-set. Predetermined time T2b and predetermined frequency F2b are pre-set in the predetermined time setting means 211 and the predetermined frequency setting means 212, respectively.

[0037]

In this embodiment, when load power 321 transitions from early morning 321a when the load power 321 is small in amount to morning 321b when the load power 321 is large in amount, for example, the load power which is not lower than a power threshold W2a occurs predetermined frequency T2a or more within predetermined time T2a, the system is started-up. In contrast, when load power 321 transitions from night 321d when the load power 321 is large in amount to midnight 321e when the load power 321 is small in amount, for example, the load power which is not higher than a power threshold W2bn for nighttime period occurs predetermined F2b or more within predetermined time T2b, the system is stopped. Although there is a time period in which the load power is small in amount in the afternoon 321c in Fig. 2, the operation is continued at the minimum output power W2d because the load power which is not higher than the power threshold W2bd for daytime period does not occur the predetermined frequency F2b or more within the predetermined time T2b. To be more specific, assuming that F2b = 70%, if the load power 321 becomes W2b or larger for a moment within the predetermined time T2b when stop determination is executed,

for example, 321g in nighttime period, this is neglected. On the other hand, if the load power 321 becomes W2bd or larger 30% or more within the predetermined time T2b when stop determination is executed, for example, 321c in daytime period, this is unable to be neglected.

[0038]

In accordance with the configuration of the fuel cell power generation system in this embodiment, as the power threshold W2b for the predetermined frequency F2 or more within the predetermined time T2b which is condition for stopping the system, the power threshold W2bd for daytime period and the power threshold 2Wbn for nighttime period are pre-set in the power threshold setting means 210. Thereby, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for the start-up is reduced even in the time period of the afternoon 321c when the load power is small in amount.

[0039] When the power threshold W2bd for daytime period and the power threshold W2bn for nighttime period are set such that W2bd < W2bn, generation of the operation stop condition in daytime period can be made less. Therefore, unnecessary stop operation is reduced and energy consumption for the stop and the associated start-up next time can be minimized. It should be noted that the power threshold W2bd for daytime period and the power threshold W2bn for nighttime period may be set by a user (or operator, manager) of the fuel cell power generation system, or operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them in the power threshold setting means 210.

[0040] In this embodiment, "the daytime period and the nighttime period are set in the timer 208." This setting may be conducted by the user (or operator, manager) of the fuel cell power generation system. Alternatively, operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them in the timer 208. In a further alternative, the control portion 206 may set first system start-up in one day as a start in daytime, and set it in the timer 208. Whereas in this embodiment, time periods in "daytime period and nighttime period" are each set to 12

hours, the time period in the daytime period may be set longer or the time period in the nighttime period may be set longer.

[0041]

(Embodiment 3)

Next, a construction and operation of the fuel cell power generation system according to this embodiment will be described with reference to Fig. 3 which is graph for explaining an example of an operation pattern of the fuel cell power generation system of this embodiment.

[0042]

The construction and operation of the fuel cell power generation system of this embodiment are similar to those of the above described fuel cell power generation system of the first embodiment. In Fig. 3, an ordinate axis indicates a power and an abscissa axis indicates a time, respectively. The load power 331 is large in amount from morning to daytime 331b and at night 331d and is small in amount at midnight 331e and early morning 331a. In afternoon 331c, there is a time period in which the load power is small in amount. In this embodiment, the fuel cell 202 is operation-controlled at output power 332 according to the power consumed by the power load 213 between the maximum output power W3c and the minimum output power W3d.

[0043]

Also, in the timer 208 of the control portion 206, for example, 6:00 to 18:00 is set as daytime period and 18: 00 to 6:00 is set as nighttime period. The timer 208 outputs those information. In the predetermined time setting means 211, predetermined time T3bd for daytime period and predetermined time T3bn for nighttime period are pre-set. A power threshold W3b is pre-set in the power threshold setting means.

[0044]

In this embodiment, when load power 331 transitions from early morning 331a when the load power 331 is small in amount to morning 331b when the load power 331 is large in amount, for example, the load power which is not lower than a

power threshold W3a continues for predetermined time T3a or more, the system is started-up. In contrast, when load power 331 transitions from night 331d when the load power 331 is large in amount to midnight 331e when the load power 331 is small in amount, for example, the load power which is not higher than a power threshold W3b for nighttime period continues for predetermined time T3b or more, the system is stopped. Although there is a time period in which the load power is small in the afternoon 331c in Fig. 3, the operation is continued at the minimum output power W3d because the load power which is not higher than the power threshold W3b for daytime period does not continue for the predetermined time T3bd or more.

[0045]

In accordance with the configuration of the fuel cell power generation system in this embodiment, as the predetermined time T3b which is condition for stopping the system, the predetermined time T3bd for daytime period and the predetermined time T3bn for nighttime period are pre-set in the predetermined time setting means 211. Thereby, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for the start-up is reduced even in the time period of the afternoon 331c when the load power is small in amount.

[0046]

When the predetermined time T3bd for daytime period and the predetermined time T3bn for nighttime period are set such that T3bd > T3bn, generation of the operation stop condition in daytime period can be made less. Therefore, unnecessary stop operation is reduced and energy consumption for the stop and the associated start-up next time can be minimized. It should be noted that the predetermined time T3bd for daytime period and the predetermined time T3bn for nighttime period may be set by a user (or operator, manager) of the fuel cell power generation system, or operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them in the predetermined time setting means 211.

[0047]

Whereas the power threshold W3b is described as instant power amount in this

embodiment, the operation may be carried out in such a manner that the power threshold W3b may be set as threshold for integrated power amount detected by the load power detecting means in the predetermined time T3bd in daytime period or the predetermined time T3bn in nighttime period which is preset. Thereby, likewise, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced even in the time period of the afternoon 331c when the load power is small in amount.

[0048]

In this embodiment, "the daytime period and the nighttime period are set in the timer 208." This setting may be conducted by the user (or operator, manager) of the fuel cell power generation system. Alternatively, operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them in the timer 208. In a further alternative, the control portion 206 may set first system start-up in one day as a start in daytime, and set it in the timer 208. Whereas in this embodiment, time periods in "daytime period and nighttime period" are each set to 12 hours, the time period in the daytime period may be set longer or the time period in the nighttime period may be set longer.

[0049]

(Embodiment 4)

Next, a construction and operation of the fuel cell power generation system according to this embodiment will be described with reference to Fig. 4 which is graph for explaining an example of an operation pattern of the fuel cell power generation system of this embodiment.

[0050]

The construction and operation of the fuel cell power generation system of this embodiment are similar to those of the above described fuel cell power generation system of the first embodiment. In Fig. 4, an ordinate axis indicates a power and an abscissa axis indicates a time, respectively. The load power 341 is large in amount from morning to daytime period 341b and at night 341d and is small in amount at

midnight 341e and early morning 341a. In afternoon 341c, there is a time period in which the load power is small in amount. In this embodiment, the fuel cell 202 is operation-controlled at output power 342 according to the power consumed by the power load 213 between a maximum output power W2c and a minimum output power W2d.

[0051]

Also, in the timer 208 of the control portion 206, for example, 6:00 to 18:00 is set as daytime period and 18: 00 to 6:00 is set as nighttime period. The timer 208 outputs those information. In the predetermined frequency setting means 212, predetermined frequency F4bd for daytime period and predetermined frequency F4bn for nighttime period are pre-set. A power threshold W4b and predetermined time T4b are pre-set in the power threshold setting means 210 and he predetermined time setting means 211, respectively.

[0052]

In this embodiment, when load power 341 transitions from early morning 341a when the load power 341 is small in amount to morning 341b when the load power 341 is large in amount, for example, the load power which is not lower than a power threshold W4a occurs predetermined frequency 4a or more within the predetermined time period T4a, the system is started-up. In contrast, when load power 341 transitions from night 341d when the load power 341 is large in amount to midnight 341e when the load power 341 is small in amount, for example, the load power which is not higher than a power threshold W4b occurs the predetermined frequency F4bn for nighttime period or more within the predetermined time T4b, the system is stopped. Although there is a time period in which the load power is small in the afternoon 341c in Fig. 4, the operation is continued at the minimum output power W4d because the load power which is not higher than the power threshold W4b does not occur the predetermined frequency F4b or more within the predetermined time T4b. To be more specific, assuming that F4b = 70% and F4bd = 98%, if the load power 341 becomes W4b or larger for a moment within the predetermined time T4b when stop determination is executed, for example, 341g in nighttime period, this is neglected. On

the other hand, if the load power 341 becomes W4b or larger at a frequency of 2% or more within the predetermined time T4b when stop determination is executed, for example, 341f in daytime period, this is unable to be neglected.

[0053]

In accordance with the configuration of the fuel cell power generation system in this embodiment, as the predetermined frequency F4 in which the load power is not higher than the power threshold W4b within the predetermined time T4b, which is condition for stopping the system, the predetermined frequency F4bd for daytime period and the predetermined frequency F4bn for nighttime period are pre-set in the predetermined frequency setting means 212. Thereby, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced even in the time period of the afternoon 341c when the load power is small in amount.

[0054]

When the predetermined frequency F4bd for daytime period and the predetermined frequency F4bn for nighttime period are set such that F4bd > F4bn, generation of the operation stop condition in daytime period can be made less. Therefore, unnecessary stop operation is reduced and energy consumption for the stop and the associated start-up next time can be minimized. It should be noted that the predetermined frequency F4bd for daytime period and the predetermined frequency F4bn for nighttime period may be set by a user (or operator, manager) of the fuel cell power generation system, or operation pattern per week (or per month per season) may be stored and learned, and the control portion 206 may set them in the predetermined frequency setting means 212.

[0055]

In this embodiment, "the daytime period and the nighttime period are set in the timer 208." This setting may be conducted by the user (or operator, manager) of the fuel cell power generation system. Alternatively, operation pattern per week (or per month, per season) may be stored and learned, and the control portion 206 may set them

in the timer 208. In a further alternative, the control portion 206 may set first system start-up in one day as a start in daytime, and set it in the timer 208. Whereas in this embodiment, time periods in "daytime period and nighttime period" are each set to 12 hours, the time period in the daytime period may be set longer or the time period in the nighttime period may be set longer.

[0056]

In the above fist to fourth embodiments, detailed description have been given that in the fuel cell power generation system which is configured to stop operation when the load power detected by the load power detecting means is smaller than the predetermined power threshold for the predetermined time or predetermined frequency within predetermined time, the power threshold, predetermined time, and predetermined frequency which are conditions for determining whether or not to stop the operation, are independently changed in daytime period and in nighttime period. But, if two or more of the power threshold, the predetermined time, and the predetermined frequency which are conditions for determining whether or not to stop the operation, may be changed at the same time in daytime and in nighttime, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced. This is because, it is obvious that preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced by changing them independently in the first to fourth embodiment. For this reason, if two or more of the power threshold, the predetermined time, and the predetermined frequency which are conditions for determining whether or not to stop the operation, at the same time in daytime period and nighttime period, the condition for determining whether or not to stop the operation produces a synergistic effect , and as a result, the number of times of unnecessary operation stop is significantly reduced.

[0057]

Thus far, the embodiments of the present invention have been described in detail.

[0058]

The present invention is a program for causing a computer to execute a whole or a part of means (or device, element, circuit, section, etc) in the above described fuel cell power generation system of the present invention, and for running in cooperation with the computer. As a matter of course, the computer of the present invention is not limited to pure hardware such as a CPU, but may be a firmware, OS, or that including peripheral device.

[0059]

The present invention is a program for causing a computer to execute a whole or a part of steps (or process, operation, function, etc) of the operation method of the above described fuel cell power generation system of the present invention, and for running in cooperation with the computer.

[0060]

It should be noted that a part of the means (or device, element, circuit, section, etc) of the present invention, and a part of steps (or process, operation, function, etc) of the present invention mean a few means or steps within the plural means or plural steps, or otherwise, a part of function or operation within one means or one step.

[0061]

It should be noted that a part of the device (or element, circuit, section, etc) of the present invention, means a few devices within plural devices, a part of means (or element, circuit, section, etc) within one device, or a part of a function within one means.

[0062]

A computer-readable storage medium which stores the program of the present invention is included in the present invention. One way in which the program of the present invention is used may be that the program is stored in the computer-readable storage medium and operate in cooperation with the computer. Another way in which the program of the present invention is used may be that the program is transmitted in a transmission medium and is read by and operates in cooperation with the computer. The storage medium includes ROM, etc, and the transmission medium includes a transmission medium such as Internet, light, electric wave, sound wave, etc.

[0063]

The configuration of the present invention may be realized in software or in hardware.

[Industrial Applicability]

[0064]

The fuel cell power generation system and the operation method of the fuel cell power generation system of the present invention have advantages that the threshold for determining whether or not to stop the operation is changed in daytime period and in nighttime period so that the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced when the power load is low in the daytime period, and is useful in the fuel cell power generation system.

[Brief Description of the Drawings]

Fig. 1 is a graph showing an example of an operation pattern of a fuel cell power generation system according to a first embodiment of the present invention;

Fig. 2 is a graph showing an example of an operation pattern of a fuel cell power generation system according to a second embodiment of the present invention;

Fig. 3 is a graph showing an example of an operation pattern of a fuel cell power generation system according to a third embodiment of the present invention;

Fig. 4 is a graph showing an example of an operation pattern of a fuel cell power generation system according to a fourth embodiment of the present invention;

Fig. 5 is a diagram showing a construction of the fuel cell power generation system according to the first embodiment of the present invention;

Fig. 6 is a diagram showing a construction of the conventional fuel cell power generation system; and

Fig. 7 is a graph showing an example of an operation pattern of the conventional fuel cell power generation system.

[Description of Reference Numerals]

[0066]

101, 202 fuel cell

102 output control means

103, 205 load power detecting means

104, 213, power load

105 storage battery

201 fuel processor

203 air blower

204 inverter

206 control portion

207 power amount changing means

208 timer

209 operation stop determination means

210 power threshold setting means

211 predetermined time setting means

212 predetermined frequency setting means

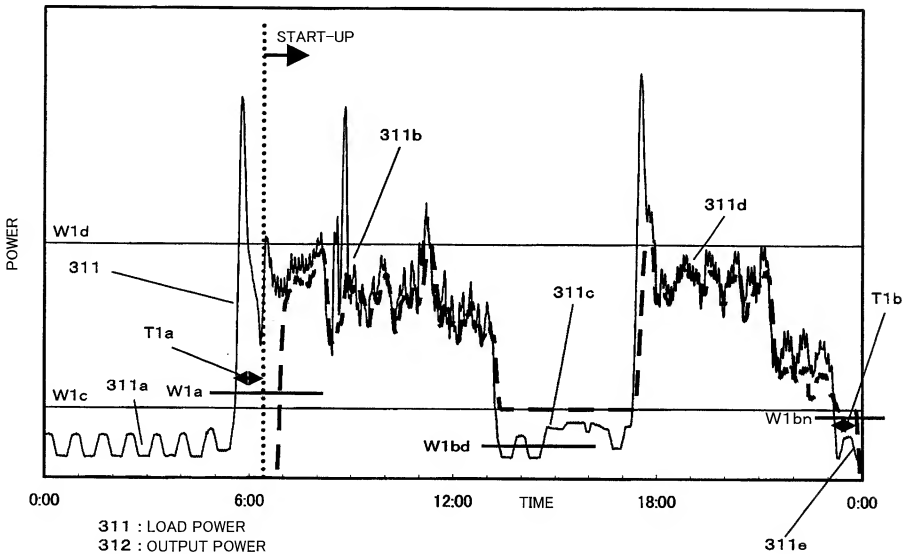
[Name of Document] Abstract

[Summary]

[Objective] A fuel cell power generation system is provided such that by changing the threshold for determining whether or not to stop the operation, preferable operation can be continued under the state where the number of times of unnecessary operation stop is reduced, and the number of times of wasteful energy consumption for start-up is reduced when the power load is low in daytime period.

[Solving means] In a fuel cell power generation system including a fuel processor 201, a fuel cell 202, and a control portion 206, the control portion 206 includes a power amount changing means 207 for changing an output power amount according to a load power, a timer 208, an operation stop determination means 209 which stops the operation when the load power detected is below a predetermined power threshold for predetermined time or predetermined frequency within predetermined time, a power threshold setting means 210, a predetermined time setting means 211, and a predetermined frequency setting means 212, for setting a power threshold, predetermined time, and predetermined frequency which are conditions for stopping a system operation.

[Selected Figure] Fig. 5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311b
311d
W1d
311
311c
T1b
T1a
W1c
311a
W1a
W1bn
W1bd
POWER
0:00
6:00
12:00
TIME
18:00
0:00
311e
311 : LOAD POWER
312 : OUTPUT POWER

Fig. 1

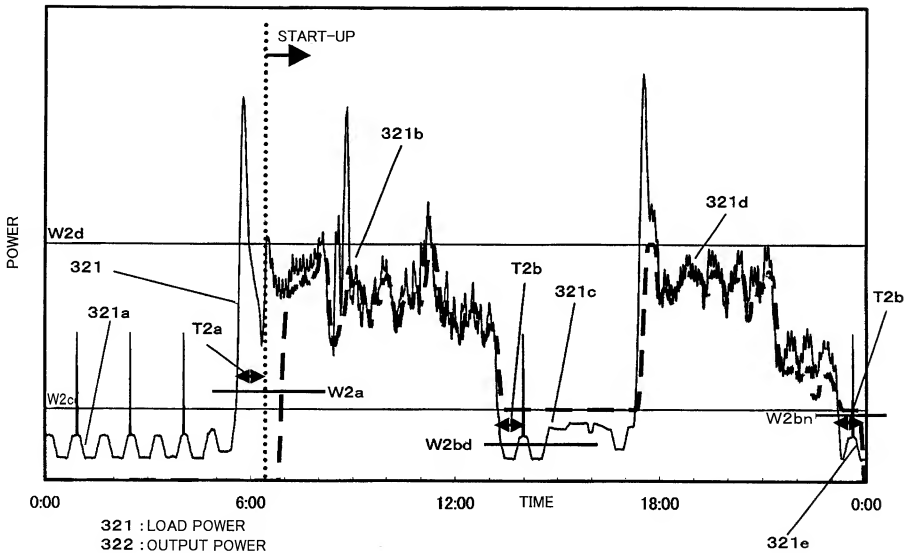
START-UP
321b
321d
W2d
POWER
321
T2b
321c
T2b
321a
T2a
W2c
W2a
W2bn
W2bd
0:00
6:00
12:00
TIME
18:00
0:00
321e
321 : LOAD POWER
322 : OUTPUT POWER

Fig. 2

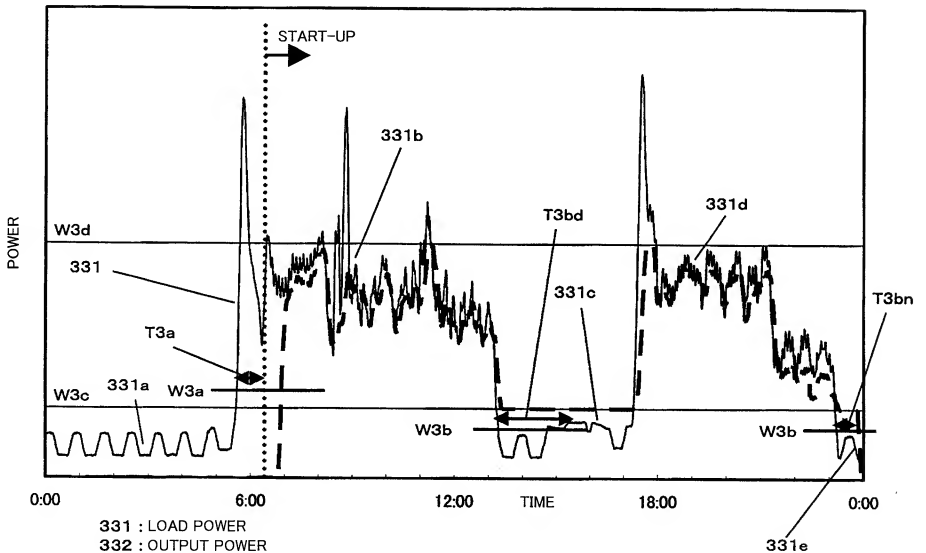
START-UP
331b
T3bd
331d
W3d
331
331c
T3bn
T3a
W3c
331a
W3a
W3b
W3b
POWER
0:00
6:00
12:00
TIME
18:00
0:00
331 : LOAD POWER
332 : OUTPUT POWER
331e

Fig. 3

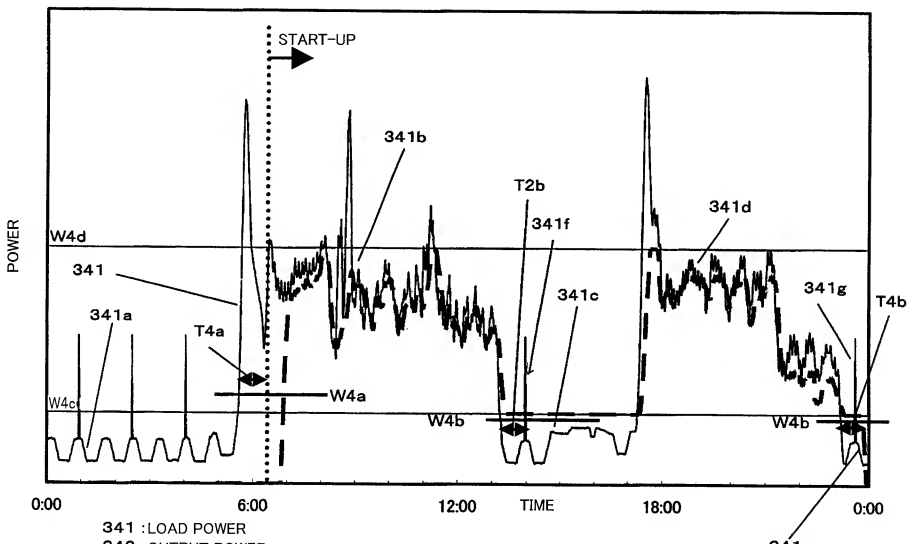
START-UP
341b
T2b
341f
341d
W4d
341
341c
341g
T4b
341a
T4a
W4a
W4c
W4b
W4b
POWER
0:00
6:00
12:00
TIME
18:00
0:00
341 :LOAD POWER
342 :OUTPUT POWER
341e

Fig. 4

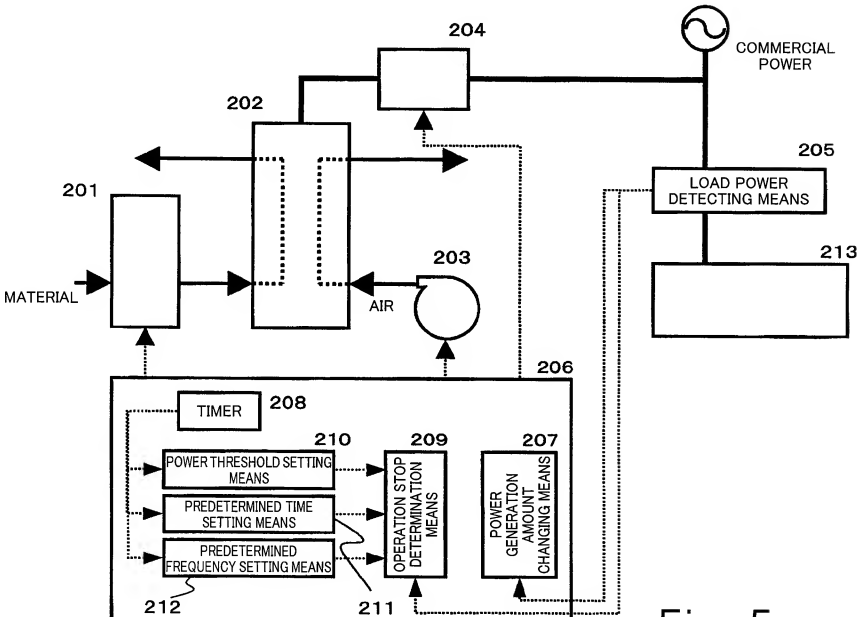
204
COMMERCIAL POWER
202
205
LOAD POWER DETECTING MEANS
201
213
203
MATERIAL
AIR
206
TIMER
208
210
209
207
POWER THRESHOLD SETTING MEANS
PREDETERMINED TIME SETTING MEANS
PREDETERMINED FREQUENCY SETTING MEANS
OPERATION STOP DETERMINATION MEANS
POWER GENERATION AMOUNT CHANGING MEANS
212
211

Fig. 5

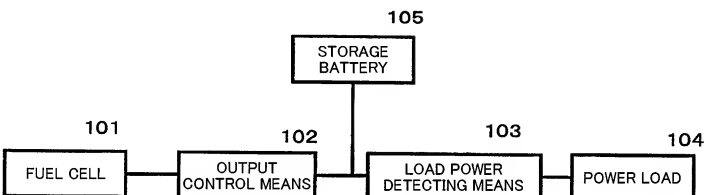
105
STORAGE BATTERY
101
FUEL CELL
102
OUTPUT CONTROL MEANS
103
LOAD POWER DETECTING MEANS
104
POWER LOAD

Fig. 6

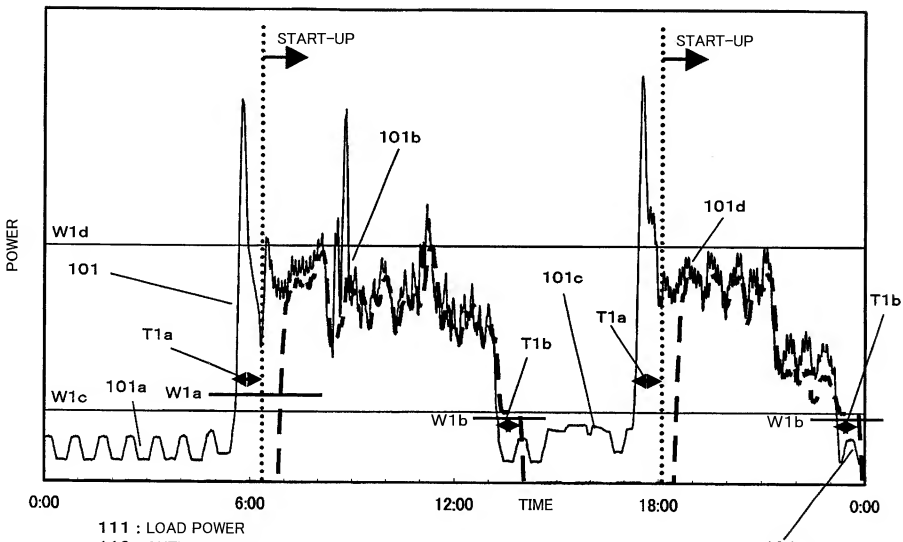
START-UP
START-UP
101b
101d
W1d
101
101c
T1a
T1b
T1a
T1b
W1c
101a
W1a
W1b
W1b
POWER
0:00
6:00
12:00
TIME
18:00
0:00
111 : LOAD POWER
112 : OUTPUT POWER
101e

Fig. 7